The waters of the Tennessee and Cumberland rivers were generally at flood stages from the 21st to the 27th and about the same period freshets occurred in the upper Potomac and James rivers.

The rivers of the east Gulf and South Atlantic systems were generally higher than in March, and in several of them the conditions were threatening about the first of the month and again near its close.

No unusual conditions were reported from the Missouri and other western streams.

The highest and lowest water, mean stage, and monthly range at 135 river stations are given in Table VII. Hydrographs for typical points on seven principal rivers are shown on Chart V. The stations selected for charting are: Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport on the Red.—*Geo. E. Hunt, Chief Clerk, Forecast Division.*

CLIMATE AND CROP SERVICE.

By JAMES BERRY, Chief of Climate and Crop Service Division.

The following extracts relating to the general weather and crop conditions in the several States and Territories are taken from the monthly reports of the respective sections of the Climate and Crop Service. The name of the section director is given after each summary.

Precipitation is expressed in inches and temperature in degrees Fahrenheit.

Alabama.—The mean temperature was 57.4°, or 6.0° below normal; the highest was 91°, at Gadsden on the 30th, and the lowest, 26°, at Tuscumbia on the 4th. The average precipitation was 5.27, or 0.78 above normal; the greatest monthly amount, 7.79, occurred at Mobile, and the least, 3.43, at Pine Apple.

Heavy rains during first few days and during latter part of second decade, inundated much prepared land, delaying planting thereon. Cool weather of first two decades, with some frost, killed much young cotton, necessitating very general replanting; damage to fruit comparatively slight.—*F. P. Chaffee.*

Arizona.—The mean temperature was 61.3°, or 2.8° below normal; the highest was 104°, at Mohawk Summit on the 14th, and the lowest, 11°, at Strawberry on the 10th. The average precipitation was 0.17, or 0.19 below normal; the greatest monthly amount, 0.90, occurred at Fort Defiance, while none fell at a number of stations.

Alfalfa, barley, and wheat, stimulated by a continued excess of temperature during the winter months, were in a forward stage of advancement in the lower agricultural valleys, and haying was in active progress by the second decade of the month. In the irrigated sections the staple crops are growing under most favorable conditions, and the outlook for more than average yield is promising.—*W. G. Burns.*

Arkansas.—The mean temperature was 58.1°, or 4.7° below normal; the highest was 96°, at Jonesboro on the 29th and 30th, and the lowest, 22°, at Pond on the 3d. The average precipitation was 3.82, or 0.71 below normal; the greatest monthly amount, 5.48, occurred at Arkadelphia, and the least, 1.37, at Arkansas City.

Cold, wet weather during the first three weeks retarded farm work and the growth of crops, but the last week was warm and favorable for planting. Corn planting was about completed, some had to be replanted, owing to the seed rotting in the ground. Cotton planting was progressing, much of the early had to be replanted. Wheat and oats were doing well, and irish potatoes were also doing well generally, but in some places they were rotting in the ground. Frost was general in the northern part of the State on the 18th and 19th and did some damage to tender vegetation. The outlook for fruit was generally good, but had been damaged slightly by frost and hail in the northern part of the State.—*E. B. Richards.*

California.—The mean temperature was 55.8°, or 1.9° below normal; the highest was 102°, at Salton on the 21st, and the lowest, zero, at Bodie on the 4th and 5th. The average precipitation was 2.16, or 0.36 above normal; the greatest monthly amount, 7.48, occurred at La Porte, while none fell at 10 stations.

Very unfavorable weather conditions prevailed during a greater part of April. The temperature was below normal, and killing frosts considerably reduced the prospective crop of deciduous fruits. Dry northerly winds and the absence of normal precipitation until near the close of the month were detrimental to late grain and pasturage. All crops were greatly benefited by the rain commencing on the 28th.—*Alexander G. McAdie.*

Colorado.—The mean temperature was 44.2°, or 1.5° below normal; the highest was 87°, at Lamar on the 25th and 30th and Las Animas on the 30th, and the lowest, 15° below zero, at Breckenridge on the 2d. The average precipitation was 2.21, or 0.51 above normal; the greatest monthly amount, 5.60, occurred at Sugar Loaf, and the least, trace, at Gunnison.

Weather more favorable than usual to agricultural interests. Cold and stormy period 9th to 16th and work at standstill in nearly all districts, but latter half of month exceedingly favorable to farming operations and advancement of vegetation. Large area set apart for sugar beets in Arkansas Valley, on western slope, and in several of the north-central counties. Wheat seeding practically completed in San Luis Park, and well advanced elsewhere. Early sown grains give promise of good stand. Fruits generally in fine condition, and outlook favorable to good crop.—*F. H. Brandenburg.*

Florida.—The mean temperature was 65.2°, or 4.2° below normal; the highest was 92°, at Clermont on the 1st, and the lowest, 33°, at St. Francis on the 22d. The average precipitation was 2.26, or 0.29 below normal; the greatest monthly amount, 7.45, occurred at Pensacola, and the least, 0.46, at Key West.

During the first decade work was delayed on lowlands, which were too wet, and where much replanting was necessary. Low temperatures during the greater portion of the month retarded the growth of all crops, particularly cotton, corn, melons, and vegetables. On the 22d frost formed inland as far south as the central district. In western and northern counties some corn and cotton were killed.—*A. J. Mitchell.*

Georgia.—The mean temperature was 57.0°, or 7.1° below normal; the highest was 91°, at Allentown on the 30th and the lowest, 29°, at Dahlonega on the 3d. The average precipitation was 4.21, or 0.76 above normal; the greatest monthly amount, 10.61, occurred at Clayton, and the least, 1.30, at Albany.

The coldest April in the history of the State climatic service, and probably the coldest within the past 30 years. Local departures of from 8° to 10° below the normal were of common occurrence. Rainfall slightly more than normal for the entire State, but deficient in the southeast. Heavy gales prevailed on several days. Effects of the weather detrimental to crops; much young cotton killed and corn damaged, and considerable replanting necessary.—*J. B. Marbury.*

Idaho.—The mean temperature was 42.8°, or 2.0° below normal; the highest was 84°, at Garnet on the 19th and 22d, and the lowest, 10° below zero, at Lake on the 1st. The average precipitation was 1.07, or 0.28 below normal; the greatest monthly amount, 2.70, occurred at Lake, and the least, 0.05, at Hailey.

No violent storms or damage reported.—*S. M. Blandford.*

Illinois.—The mean temperature was 50.1°, or 2 5° below normal; the highest was 93°, at Bloomington and Centralia on the 29th, and the lowest, 21°, at Dwight on the 1st. The average precipitation was 1.86, or 1.45 below normal; the greatest monthly amount, 3.98, occurred at Raum, and the least, 0.13, at Bushnell.

Cold weather retarded growth of vegetation during the greater part of the month, and wet weather delayed the seeding of oats and farm work generally. Warm and dry weather at the end of the month advanced farm work and vegetation rapidly.—*M. E. Blystone.*

Indiana.—The mean temperature was 48.7°, or 3.7° below normal; the highest was 92°, at Terre Haute on the 30th, and the lowest, 20°, at Syracuse on the 1st. The average precipitation was 2.67, or 0.30 below normal; the greatest monthly amount, 7.12, occurred at Greensburg, and the least, 0.69, at Hammond.

Frequent rains improved growing crops, but, the ground being too wet in most fields, plowing for corn, seeding, and gardening progressed slowly. Cool and generally cloudy weather prevailing, growing crops improved very slowly, and trees and shrubs remained leafless until the last few days of the month, when the exceedingly warm, sunny weather brought out the foliage, crops grew more rapidly, and everything looked bright and green. Ice and white frost in localities on the 19th and 20th apparently caused no great damage. At the end of the month wheat, rye, clover, timothy, pasturage, and meadows were much improved and in excellent condition. Tobacco plants were coming up nicely. Barley and oats were nearly all sown; early-sown oats were coming up well in some fields. Plum, peach, apricot, and cherry trees were in bloom, and other fruit buds were swelling. Most of the gardens were made and nearly all of the early potatoes had been planted. Plowing for corn

advanced quite rapidly during the last few days, and in a few fields corn was planted. Sheep shearing had begun in the southern portion of the State. Live stock was in good condition. Floods in the Ohio River bottoms destroyed many fields of wheat.—*C. F. R. Wappenhans.*

Iowa.—The mean temperature was 49.9°, or about normal; the highest was 92°, at Sigourney and Fruitland on the 29th and 30th, and the lowest, 15°, at Monticello on the 1st. The average precipitation was 1.79, or 1.41 below normal; the greatest monthly amount, 3.47, occurred at College Springs, and the least, 0.66, at Le Claire.

Season opened late, farming operations being delayed by excessive moisture in March and early part of April. Seeding progressed slowly through first and second decades. Last decade warm, dry, and favorable for seeding and plowing. A beginning was made in corn planting as early as the 27th. The season was favorable for pastures, meadows, and fruit.—*John R. Sage.*

Kansas.—The mean temperature was 53.0°, or 3.0° below normal; the highest was 96°, at Gove on the 26th, and the lowest, 12°, at Tribune on the 2d. The average precipitation was 3.71, or 1.34 above normal; the greatest monthly amount, 7.25, occurred at Anthony, and the least, 1.46, at Wallace.

A cool month, the temperature being below normal until the 24th, when it rose above normal, remaining above the rest of the month. The precipitation was quite excessive during the first half, with occasional showers the last half of the month. The wet weather prevented farm work during a large part of the month, but the warm, dry weather the last of the month made great changes. Wheat grew rapidly. At the close of the month corn planting was well advanced in southern and had begun in northern counties; peaches and plums in bloom in north, apples in south; oat and flax sowing about finished, with oats coming up; alfalfa growing rapidly and pastures beginning to support stock.—*T. B. Jennings.*

Kentucky.—The mean temperature was 50.9°, or 5.3° below normal; the highest was 91°, at Earlington on the 29th and at Greensburg, Manchester, and Paducah on the 30th, and the lowest, 23°, at Shelby City on the 9th. The average precipitation was 4.01, or 0.18 above normal; the greatest monthly amount, 7.23, occurred at Williamsburg, and the least, 2.22, at St. John.

A very cold, backward month. An extremely cold spell occurred from the 18th to the 25th, with freezing weather at many stations and heavy snow on the 19th and 20th in the eastern portion. Nothing was seriously injured by the cold spell, but the growth of all vegetation was checked, and in many places corn had rotted in the ground, making it necessary to replant many fields. The month closed with mild, pleasant weather.—*H. B. Hersey.*

Louisiana.—The mean temperature was 63.1°, or 4.3° below normal; the highest was 95°, at Covington on the 30th, and the lowest, 28°, at Plain Dealing on the 3d. The average precipitation was 5.39, or 0.65 above normal; the greatest monthly amount, 10.30, occurred at New Iberia, and the least, 2.39, at Alexandria.

With the exception that low temperature retarded germination and growth of vegetation, the weather was very favorable to agricultural interests during the first half of April. Plowing and planting were further advanced than is usual at that time of year. On the 17th and 18th heavy and in many places flooding rains fell, washed out planted corn and cotton or packed the ground so that the sprouts from recently-planted seed could not get through; drowned some rice, and made it necessary to plow and plant again a large acreage of cotton and replant much corn. The rains were followed by frost on the 19th and 20th, and low temperatures for several days, causing further injury to corn and cotton that were above ground. At the last of the month higher temperature prevailed and farm work was progressing rapidly.—*W. T. Blythe.*

Maryland and Delaware.—The mean temperature was 49.2°, or 2.8° below normal; the highest was 90°, at Hancock, Md., on the 29th and 30th, and the lowest, 15°, at Deerpark, Md., on the 12th. The average precipitation was 5.72, or 2.80 above normal; the greatest monthly amount, 7.97, occurred at Frostburg, Md., and the least, 3.30, at Harney, Md.

A March type of weather conditions continued into April, cold, cloudy, and wet, with frequent stormy periods. Fortunately there were no severe cold waves or damaging frosts to hurt field crops or fruit in the interior, while in the mountain districts of the extreme west all tender vegetation was dormant, so that the heavy snows and low temperatures of that section were without injury. The month closed with work behind, and the season late for oats, tobacco, corn, and minor crops. Wheat, rye, and barley, are excellent in growth; grass not so good; fruit outlook unimpaired in all districts.—*Oliver L. Fussig.*

Michigan.—The mean temperature was 44.4°, or 0.9° above normal; the highest was 88°, at Houghton on the 27th, and the lowest, zero, at Thomaston on the 1st. The average precipitation was 1.34, or 0.71 below normal; the greatest monthly amount, 3.30, occurred at Arbela, and the least, 0.10, at Ewen

The advance of the season has been quite steady and equable during April. The early part of the month was dry, but sufficient rainfall occurred during the period extending from the 16th to the 24th to generally benefit wheat, rye, clover, meadows, pastures, and plowing. At the close of the month all fruit buds were in excellent condition, not having been forced by any early warm waves, and promising abundant yields; oat seeding was well advanced and plowing for corn, beans, and potatoes general.—*C. F. Schneider.*

Minnesota.—The mean temperature was 46.7°, or 2.0° above normal; the highest was 91°, at Willow River on the 29th, and the lowest, 6°, at Lake Winnibigoshish on the 17th. The average precipitation was 1.73, or 1.00 below normal; the greatest monthly amount, 3.34, occurred at Pine River Dam, and the least, 0.66, at Glencoe.

Weather conditions have generally been favorable for farm work, except in southeastern counties, where it was too wet until late in the month. Wheat seeding begun in central and southwestern portions by the 5th, was nearly finished by the end of the month in all parts of the State, except on the low lands of the Red River Valley. Oats and barley were also nearly all seeded, except in the southeastern counties. Early sown wheat was coming up nicely late in the month.—*T. S. Outram.*

Mississippi.—The mean temperature was 60.0°, or 5.1° below normal; the highest was 97°, at Windham on the 30th, and the lowest, 30°, at Saratoga on the 21st. The average precipitation was 4.36, or 0.13 below normal; the greatest monthly amount, 9.05, occurred at Biloxi, and the least, 1.28, at Hernando.

Frosts from the 19th to 22d, inclusive, together with previous cool weather, killed nearly all cotton that was up, caused sprouting seed to rot, and injured corn in many counties.—*W. S. Belden.*

Missouri.—The mean temperature was 53.2°, or 2.6° below normal; the highest was 94°, at Unionville on the 29th, and the lowest, 24°, at Potosi on the 21st. The average precipitation was 2.85, or 0.94 below normal; the greatest monthly amount, 5.41, occurred at Cowgill, and the least, 0.89, at Steffenville.

From April 1st to 18th the weather was generally cold, stormy, and disagreeable, with snow on the 1st and 2d, and again on the 17th, and little farm work was done; but during the last ten days of the month the weather was all that could be desired and work progressed rapidly. By the close of the month oat sowing was completed and corn planting was well under way in most sections. Heavy frosts on the 18th, 19th, 20th, and 21st damaged fruit buds to some extent in a few of the southern counties, but in general fruits of all kinds escaped injury and promised an abundant crop. Winter wheat continued in excellent condition, as a rule.—*A. E. Hackett.*

Montana.—The mean temperature was 42.6°, or 0.8° below normal; the highest was 92°, at Ridgelawn on the 30th, and the lowest, 1° below zero, at Adel on the 27th. The average precipitation was 1.19, or 0.04 below normal; the greatest monthly amount, 3.26, occurred at Dillon, and the least, trace, at Ekalaka.

The season is three weeks later than last year. Grass is very slow in starting. Heavy snow on April 26th in the west and central portions was very beneficial to crops and grass on the ranges.—*E. J. Gluss.*

Nebraska.—The mean temperature was 48.9°, or 0.4° below normal; the highest was 95°, at Beaver City on the 26th, and the lowest, 5°, at Curtis on the 1st. The average precipitation was 2.32, or 0.25 below normal; the greatest monthly amount, 6.01, occurred at Holdrege, and the least, 0.40, at Pleasanthill.

Nearly a normal month in temperature and rainfall, and all crops have grown well. Winter wheat is in especially good condition.—*G. A. Loveland.*

Nevada.—The mean temperature was 45.3°, or 1.9° below normal; the highest was 98°, at Las Vegas, and the lowest, 2° below zero, at Monitor Mill. The average precipitation was 0.59, or 0.13 below normal; the greatest monthly amount, 2.20, occurred at Lewers Ranch, while none fell at Los Vegas.

The first half of the month was cold and unfavorable for the germination of seed and the growth of grass, grain, and alfalfa. The latter half was much warmer and more favorable to agricultural interests. Heavy and widely distributed showers on the 30th were of immense benefit to all kinds of vegetation.—*J. H. Smith.*

New England.—The mean temperature was 44.7°, or 1.0° below normal; the highest was 87°, at North Grovenor Dale, Conn., on the 29th, and the lowest, 15°, at Flagstaff, Me., on the 12d. The average precipitation was 6.86, or 3.85 above normal; the greatest monthly amount, 13.37, occurred at Middletown, Conn., and the least, 1.74, at St. Johnsbury, Vt.

Generally cloudy and cool weather, with excessive precipitation. No severe or destructive storms. Growing crops, winter grain, and grass are in good condition; the latter assures a large hay crop. Spring planting and seeding retarded by unfavorable weather and wet condition of soil. The season is somewhat backward, variously estimated from a week to ten days.—*J. W. Smith.*

New Jersey.—The mean temperature was 48.3°, or 0.8° below normal; the highest was 89°, at Belvidere and Paterson on the 30th, and the lowest, 23°, at Charlotteburg on the 13th. The average precipitation was 6.31, or 2.89 above normal; the greatest monthly amount, 10.22, occurred at Charlotteburg, and the least, 3.46, at Atlantic City.

Weather conditions during the month were most unfavorable for all farming operations; frequent heavy rains delayed plowing and planting and the cool easterly winds, with almost continued cloudiness, retarded germination and plant growth. Winter wheat, rye, and grass are all backward. The rainfall at New Brunswick, 7.75 inches, is the largest recorded since 1874, when it was 8.25.—*E. W. McGann.*

New Mexico.—The mean temperature was 50.6° or 2.0° below normal; the highest was 100°, at San Marcial on the 28th, and the lowest, 3°, at Winsors on the 2d. The average precipitation was 0.70, or about normal; the greatest monthly amount, 3.43, occurred at Folsom, while none fell at Gage, and only trace at Deming and San Marcial.

Cool and windy; vegetation backward.—*R. M. Hardinge.*

New York.—The mean temperature was 45.2°, or 1.4° above normal; the highest was 86°, at Cedar Hill and Wells on the 29th, and the lowest, 14° at Adirondack Lodge on the 12th. The average precipitation was 5.19, or 2.64 above normal; the greatest monthly amount, 11.32, occurred at Mohonk Lake, and the least, 0.95, at Number Four.

Farm operations were delayed during the first half of the month by cold, wet weather, but some progress was made during the latter half, the season, however, being very backward and work much delayed. The precipitation was heavier than during any other April in twelve years, causing much damage by floods and seriously delaying work on low lands.—*R. G. Allen.*

North Carolina.—The mean temperature was 52.4°, or 5.3° below normal; the highest was 89°, at Brewers on the 30th, and the lowest, 21°, at Highlands on the 22d. The average precipitation was 5.83, or 2.06 above normal; the greatest monthly amount, 10.53, occurred at Patterson, and the least, 2.00, at Wilmington.

The month was decidedly unfavorable for farm work and for the growth of crops, on account of the heavy rains at the beginning and during the middle portion of the month, and the continuously cold weather, which prevented germination and growth. In spite of the heavy snowstorm and freezing temperatures in the western district, April 20–21st, the fruit crop was not seriously injured. Wheat, rye, and oats continued in excellent condition. Planting cotton and corn was much delayed and considerable replanting was necessary.—*C. F. von Herrmann.*

North Dakota.—The mean temperature was 44.5°, or 3.3° above normal; the highest was 92°, at Berthold Agency and Medora on the 30th, and the lowest, 10°, at Falconer on the 17th. The average precipitation was 0.98, or 0.81 below normal; the greatest monthly amount, 2.89, occurred at Larimore, and the least, trace, at Coal Harbor, New England City, and Steele.

The greater part of the month was not generably favorable for farm work. High winds, with considerable freezing weather, delayed seeding until the last of the month, when it progressed rapidly under very favorable conditions.—*B. H. Bronson.*

Ohio.—The mean temperature was 46.7°, or 3.8° below normal; the highest was 91°, at Annapolis on the 30th, and the lowest, 18°, at Green Hill and Warsaw on the 1st. The average precipitation was 3.40, or 0.48 above normal; the greatest monthly amount, 8.96, occurred at Lowell, and the least, 1.12, at Cardington.

The mean temperature for the State was the lowest recorded in April since the establishment of the voluntary service in 1883. The snowstorm of the 19th to 22d was phenomenal, and accompanied by heavy rainfall, caused very damaging floods in the Ohio Valley. Wheat fields were in a more flourishing condition at the end of the month than at any previous date this spring. Corn planting generally begun in the south. Fruit blooming very heavily.—*J. Warren Smith.*

Oklahoma and Indian Territories.—The mean temperature was 57.8°, or 3.6° below normal; the highest was 97°, at Pawhuska on the 25th and 26th, and the lowest, 23°, at Kenton on the 6th. The average precipitation was 2.95, or 0.41 above normal; the greatest monthly amount, 7.90, occurred at Tahlequah, Ind. T., and the least, 1.00, at Colbert, Ind. T.

The forepart of the month was unusually cold and greatly hindered the growth and germination of the crops in the ground. Killing frosts occurred on the 17th and 18th. A general storm of sleet and snow on the 17th, and a violent local thunderstorm on the 26th in Woods County, caused considerable damage. Wheat and oats made a slow growth and were badly damaged by insects, particularly oats, the damage ranging from slight to a total loss as one progresses southward. Corn, cotton, millet, and other crops were being planted and coming up to good stands.—*Charles M. Strong.*

Oregon.—The mean temperature was 47.5°, or 1.6° below normal; the highest was 78°, at Grants Pass on the 2d, at Aurora on the 9th, and at Buckhorn Farm on the 17th, and the lowest, 11°, at Silverlake on the 6th. The average precipitation was 3.27, or 0.07 above normal; the greatest monthly amount, 13.05, occurred at Glenora, and the least, trace, at Prineville.

The month was cool throughout, with frosty nights and moderately warm days. Crops in general made slow but satisfactory advancement. Peaches, apricots, and early cherries were considerably damaged by frosts, but other fruit, especially apples and prunes, promise well.—*Edward A. Beals.*

Pennsylvania.—The mean temperature was 47.2°, or 0.7° below normal; the highest was 95°, at Carlisle on the 29th, and the lowest, 16°, at Hawthorn on the 12th. The average precipitation was 5.41, or 1.94 above normal; the greatest monthly amount, 9.18, occurred at Chambersburg, and the least, 1.46, at Carlisle.

Heavy precipitation and much cloudiness have made the season backward for crops. Up to the 26th little farm work was accomplished. Ground much of the time was too wet to plow, and little planting was undertaken except on high lands and hills. Cold and wet condition of ground was unfavorable for germination of seed, and at some places replanting will be necessary, as seed rotted. Following a long period of wet and cloudy weather the last four days of the month were ideal. The sun shone from morn till night and temperatures ranged up to summer heat. With a prolongation of fair weather farm work will be pushed rapidly throughout the State.—*L. M. Dey.*

Porto Rico.—The mean temperature was 77.5°, or 1.8° above normal; the highest was 97°, at Bayamon on the 7th and 29th, and at Cayey on the 7th, and the lowest, 54°, at Cidra on the 1st. The average precipitation was 3.00, or 3.30 above normal; the greatest monthly amount, 8.68, occurred at Isabella, and the least, 0.21, at Comerio.

The weather during April was somewhat unfavorable for general farming interests. Crops over the southern portion of the island were badly damaged by the drought. Pasturage is very scarce and stock is suffering. Planting of new crops has been retarded in most districts, and at the close of the month rain was badly needed, especially over the southern portions of the island. Conditions were exceptionally favorable for saving sugar cane. Grinding has been rushed and is nearing completion on some of the small plantations. A large acreage has been devoted to sugar cane, but the yield is not as good as was expected. The new crop of cane is doing well, except where damaged by the drought. Some cane is still being planted, and with favorable weather, an increased acreage is promised. Coffee is doing exceptionally well, auguring a good yield. Berries have formed and are growing very fast; some now taking on a perfect formation. Cutting and curing of tobacco continues; harvesting of the crop is nearing completion.—*Joseph L. Cline.*

South Carolina.—The mean temperature was 56.0°, or 6.2° below normal; the highest was 89°, at Spartanburg on the 30th, and the lowest, 30°, at Liberty on the 4th. The average precipitation was 5.03, or 2.00 above normal; the greatest monthly amount, 10.58, occurred at Yorkville, and the least, 1.64, at Charleston.

It was the coolest April of record, and ranks third in precipitation. The general weather conditions were unfavorable for preparing lands, planting, germination, and for growth of vegetation. Corn and cotton planted early in the month did not come up well and much replanting was necessary. Fruit escaped the numerous light frosts unhurt.—*J. W. Bauer.*

South Dakota.—The mean temperature was 48.8°, or 2.0° above normal; the highest was 96°, at Forestburg on the 30th, and the lowest, 11°, at Redfield on the 17th. The average precipitation was 1.56, or 1.20 below normal; the greatest monthly amount, 2.95, occurred at Oelrichs, and the least, 0.12, at Mound City.

Prior to the 20th the seeding, germination, and growth of spring wheat, oats, barley, and rye, and the growth of grass, were retarded by showers or cool weather and to some extent by frosty nights, but fairly good progress was made. After the 20th the conditions were generally more favorable for germination and growth and healthy progress of all vegetation, except that a southerly gale on the 26th uncovered some spring wheat and oats on light soil, necessitating some reseeding.—*S. W. Glenn.*

Tennessee.—The mean temperature was 53.1°, or 5.0° below normal; the highest was 90°, at Johnsonville, Liberty, and Memphis on the 30th, and the lowest, 23°, at Bristol on the 20th. The average precipitation was 4.70, or 0.10 above normal; the greatest monthly amount, 8.72, occurred at Rugby, and the least, 1.60, at Memphis.

The first three weeks were unfavorable to seed in the ground and to young plants on account of the low temperature and lack of sunshine, but the month closed with a week of very fine spring weather, which had an exceedingly favorable effect on vegetation generally. At the close of the month wheat and oats were in fine condition of growth, as a rule; the bulk of the cotton area had been planted; stands of early corn were poor; tobacco plants were small but healthy; fruit was not materially injured by the cold.—*Roscoe Nunn.*

Texas.—The mean temperature was 63.0°, or 3.3° below normal; the highest was 100°, at Fort Ringgold on the 16th, and the lowest, 26°, at Amarillo and Hale Center on the 2d. The average precipitation was 1.97, or 0.73 below normal; the greatest monthly amount, 6.45, occurred at Camp Eagle Pass, while none fell at Valentine.

The rainfall continued below normal throughout the month, and in some localities the deficiency was marked. The bulk of the corn crop was in the ground before the opening of the month, but planting was carried on in scattered localities during the month. Cool nights and dry weather proved very unfavorable. Cotton planting was retarded by dry weather; that put in the ground early in the month came up to good stands, but later planting did not come up well. Dry weather and insects seriously injured the wheat and oat crops.—*I. M. Cline.*

Utah.—The mean temperature was 46.2°, or 1.5° below normal; the highest was 89°, at Hite and Moab on the 30th, and the lowest, zero, at Loa on the 7th. The average precipitation was 0.69, or 0.46 below normal; the greatest monthly amount, 2.35, occurred at Fillmore, and the least, trace, at Emery.—*L. H. Murdoch.*

Virginia.—The mean temperature was 50.0°, or 4.6° below normal; the highest was 92°, at Fontella on the 30th, and the lowest, 21°, at Burkes Garden on the 21st. The average precipitation was 6.04, or 2.77 above normal; the greatest monthly amount, 9.10, occurred at Wytheville, and the least, 3.45, at Birdsnest.

The month was unusually cold, cloudy, and stormy, and the advance of vegetation, as well as the progress of farm work incident to the season, was greatly delayed. Snow fell to unusual amounts in portions of the Great Valley division, and light to killing frosts occurred, but no special damage resulted from either.—*Edward A. Evans.*

Washington.—The mean temperature was 45.9°, or 2.2° below normal; the highest was 79°, at Pasco on the 10th, and the lowest, 11°, at Republic on the 3d. The average precipitation was 3.49, or 0.76 above normal; the greatest monthly amount, 13.42, occurred at Clearwater, and the least, trace, at Pasco.

The weather was in general too cool for rapid growth of crops, but was not unfavorable to winter wheat and early spring wheat. Spring seeding was late and fruit bloomed two or three weeks later than usual.—*G. N. Salisbury.*

West Virginia.—The mean temperature was 47.5°, or 5.1° below normal; the highest was 95°, at Point Pleasant on the 30th, and the lowest, 18°, at Philippi on the 1st. The average precipitation was 7.05, or 3.53 above normal; the greatest monthly amount, 10.70, occurred at Clay, and the least, 4.95, at Beverly.

The cold, stormy, and unseasonable weather, with excessive precipitation, was very unfavorable for farm work and the growth of vegetation, so that little advancement was made. At the close of the month work was behind, grass short, gardens backward, wheat below average condition, feed scarce, stock in poor condition and the prospects for fruit promising.—*E. C. Vose.*

Wisconsin.—The mean temperature was 46.7°, or 2.2° above normal; the highest was 90°, at Prairie du Chien and Pine River on the 30th, and the lowest, 12°, at Amherst on the 1st and at Spooner on the 19th. The average precipitation was 0.85, or 1.92 below normal; the greatest monthly amount, 2.22, occurred at Barron, and the least, trace, at West Bend.

The month was one of the driest Aprils on record, especially in the southern section, where the total precipitation was only about 20 per cent of the normal. The effect of the drought is most noticeable on meadows and pastures. Early sown grain is coming up nicely and preparations for corn and potatoes are progressing rapidly.—*W. M. Wilson.*

Wyoming.—The mean temperature was 40.3°, or 1.0° below normal; the highest was 88°, at Alcova on the 28th, and the lowest, 15° below zero, at Centennial on the 17th. The average precipitation was 1.31, or 0.40 below normal; the greatest monthly amount, 3.11, occurred at Lander, while none fell at Lovell (Byron P. O.)—*W. S. Palmer.*

SPECIAL CONTRIBUTIONS.

THE THEORY OF THE FORMATION OF PRECIPITATION ON MOUNTAIN SLOPES.

By Prof. F. POCKELS, School of Technology, Dresden, Germany. Translated from Ann. d. Physik, 1901. (4) Vol. III, pp. 459-480.

It is a well known principle of climatology that the side of a mountain range which is turned toward the prevailing wind has in general a greater precipitation than the plain on the windward side, and a still greater in comparison with the leeward side of the mountain range. There has been no doubt as to the explanation of this phenomenon since it has been recognized that the principal cause of the condensation of the aqueous vapor is the adiabatic cooling of the rising mass of air; for a current of air impinging against rising ground must, in order to pass over it, necessarily rise. So far as the author knows, however, no attempt has yet been made to investigate this process quantitatively, except perhaps, for the stratum of air immediately contiguous to the earth, whose ascension being equal to that of the surface itself, is thereby known directly. Such a quantitative treatment will be attempted in the following article. Even although this is only possible under special assumptions which represent nature with the closest approximation, it will, however, always offer a practical basis for estimating the purely mechanical influence exerted by the configuration of the surface of the earth on the formation of rain.

1.

In order to find the standard vertical components of the velocity of the air currents that determine the condensation, we must, first of all, solve the hydrodynamic problem of the movement of the air over a rigid surface of a given shape. In this connection we must make a series of simplified assumptions, as follows:

1. The current must be stationary; 2, it must be continuous and free from whirls; 3, it must flow everywhere parallel to a definite vertical plane, and consequently depend only on the vertical coordinate (y), and one horizontal coordinate (x); 4, the internal friction, as well as the external (or that due to the earth's surface), may be neglected; 5, at great heights there must prevail a purely horizontal current of constant velocity, a. As to the configuration of the ground, we must, corresponding to proposition 3, assume that the profile curves are identical in all vertical planes that are parallel to the plane of $x\,y$; 6, and further, we assume the surface profile to be *periodic*, that is to say, the surface of the earth is formed of similar parallel waves of mountains without, however, determining in advance the special equation of the profile curves.

If we designate by u and v the horizontal and vertical components of velocity and by ε the density, then, in consequence of assumptions 1 and 3, there follows the condition

$$\frac{\partial(\varepsilon u)}{\partial x}+\frac{\partial(\varepsilon v)}{\partial y}=0$$

and in consequence of 2 there must exist a velocity potential, φ, which, according to 3, can only depend upon x and y, so that

$$u=\frac{\partial\varphi}{\partial x}\quad v=\frac{\partial\varphi}{\partial y},\text{ and }\frac{\partial}{\partial x}\left(\varepsilon\frac{\partial\varphi}{\partial x}\right)+\frac{\partial}{\partial y}\left(\varepsilon\frac{\partial\varphi}{\partial y}\right)=0.$$

If we consider that the density of the air in a horizontal direction (excluding large differences of temperature at the same level) changes much more slowly in a horizontal than in a vertical direction, then we can regard ε as a function of y only, and obtain for φ the differential equation—

$$\varepsilon\,\Delta\varphi=-\frac{\partial\varepsilon}{\partial y}\frac{\partial\varphi}{\partial y}. \tag{1}$$

The law of the diminution of density with altitude will, strictly speaking, be different for each particular case, because the vertical diminution of temperature in a rising current of air, which determines the rate of diminution of density, depends upon the condensation. But it is allowable, as a close approximation and as is usually done in barometric hypsometry, to assume the law of diminution of pressure which obtains, strictly speaking, for a constant temperature only, and which, as is well known, reads as follows:

$$\text{nat log}\frac{p_0}{p}=q\,y,$$

where q is a constant and has very nearly the value of 1/8000 if y, the difference in altitude, be expressed in meters. In this case the following also holds good:

$$\log\frac{\varepsilon_0}{\varepsilon}=q\,y,$$

and, consequently,

$$-\frac{1}{\varepsilon}\frac{\partial\varepsilon}{\partial y}=q;$$

hence the differential equation for φ becomes

$$\Delta\varphi=q\frac{\partial\varphi}{\partial y}. \tag{2}$$

A solution of this differential equation that satisfies the assumptions 5 and 6, is given by the expression